

**Red Palm Weevil, *Rhychophorus ferrugineus*
Technical Working Group Recommendations**

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The recommendations described in this document were developed by the Red Palm Weevil (RPW) Technical Working Group (TWG) on October 27, 2010.

Agenda:

- Introductions and structure of group (Ken Bloem)
- Update of program activities and weevil finds to date (Kevin Hoffman & Staff)
- Priority questions from program (Kevin Hoffman, APHIS-PPQ Staff)
 - 1) Can infested trees be treated to ensure 100% RPW mortality or do they need to be cut down and destroyed to eliminate an infestation?
 - 2) How far out from a confirmed find do you need to put traps to delimit the potential size of an infestation?
 - 3) Are there any treatments that would allow nursery stock to be moved out of a regulated area; and if so, what are they?
 - 4) Can fronds alone support weevil development and be a pathway for spread?

Goal:

To provide a written report that includes the most up-to-date information on survey, mitigation and basic biology of the RPW to help program personnel formulate a response to the recent detection of the pest in southern California.

Update on Weevil Detection and Program Activities:

- On September 1, 2010, a pest control advisor with a local Orange County landscaping company submitted a weevil to county agriculture officials collected from a dead canary palm tree in late August 2010, in Laguna Beach, Orange County. The California Department of Food and Agriculture (CDFA) identified the weevil as red palm weevil and sent the sample to USDA's Systematic Entomology Laboratory (SEL), the Department's national identification laboratory located in Beltsville, MD. SEL identifiers confirmed the specimen as red palm weevil. However, the sample was not considered 'official' because the infested tree had been removed, chipped and composted before CDFA or another regulatory agency could examine it.
- All three trees identified by the landscaping company as being infested were taken out in late August. The crowns were chipped and the trunks were cut up and taken to the landfill as green waste.
- A second dead red palm weevil was found by CDFA in the remains of one of the removed palm trees. SEL confirmed the specimen as red palm weevil. This weevil became the official first find.
- There are reports from other landscaping companies that they have seen similar damage (crowns falling) in Newport, California.
- An intensive visual ground survey of palm trees within a 1-mile radius was conducted immediately following the initial suspect identification. Additionally, public outreach/education activities in residential areas around the detection site. To date, 1481 properties and 9721 palm trees were surveyed within a 1.5-mile radius of the initial find.
- The 1 mile core area is bordered by the ocean on one side and a wilderness area on the other. Reports indicate that native palm trees (*Washingtonia* spp.) and naturalized *Phoenix* spp. are present in the area.

- Pheromone (Ferrolure+ 700mg and weevil magnet 40 ml ethyl acetate) baited bucket traps with a 50% mixture of coolant and water and cut apples were deployed in the core area on Oct 7, 2010, and in the buffer area on Oct 14, 2010. Bucket traps were hung approximately 7-8 feet high on palm trees to avoid potential problems with pets and children.
- Traps were inspected daily for the presence of weevils for three weeks and weekly thereafter.
- To date, no weevils have been collected in the traps.
- On Oct 26, a live adult suspect and multiple dead adults and cocoon cases were found in canary palm tree in an alleyway near the original find.
- All infested palm trees have been large, established Canary Island date palm trees. There was no evidence of the infested plants being recently planted.
- Residents have been providing anecdotal evidence that there were some large Canary Island date palm trees that were in the area in 2008, but were removed in 2009. Most of the trees that were apparently removed were located within a 200-yard radius of the first find.
- Some residents believe that they have seen damage similar to that caused by the weevil since 2009. However, upon inspection, the weevils could not be found.

Biology

- 1 Is there sufficient DNA knowledge of populations to use for pathway analysis?
 - The TWG is not aware of any current efforts to develop DNA markers or evaluate populations.
 - Spain has collected material (antennae) from various infestations and locations and offered to supply material to cooperators that are interested in conducting molecular studies.
 - Identity of RPW: There was concern about the taxonomy of the RPW found in Orange County. They appear to have a distinctive color in contrast to those from Europe/Middle East and the Caribbean. They are generally dark with a medium red stripe. This is more consistent with the color morphs from Vietnam and South East Asia. While RPW generally display a considerable amount of color variation, it would be beneficial to see if these color morphs are different using molecular diagnostic techniques. In the past, there have apparently been several groups that have looked at genetic comparisons of RPW but no data has been published. It would be useful for such a study to be conducted and to be published in peer-reviewed journals.

- 2 How synchronous are the populations?
 - In Spain, there are two main peaks in adult captures/flight; in the spring from the overwintering generation from the previous year and a larger peak in September/October that completes the generation from that year. In the warmer parts of Israel, more generations may occur, depending upon the temperature. Temperature range is 15 degrees to 19 degrees Celsius. Temperature range affects the number of generations so the further the weevils are from the coast, the more generations are possible.
 - High populations are likely to have all life stages year-round. However, all stages can also be found in one palm tree from the second generation onwards, even when populations are low.
 - Emerging adults often oviposit on the same tree for two to three generations, which is usually the time that it takes to kill the palm tree. For this reason, by the time symptoms are detected, a tree will probably have been infested for up to two years. In Eilat, southern Israel, and surrounding areas, there are four generations a year. In northern Israel, which has a climate similar to California, there are two to three generations. It is possible that different palm species might furnish different nutrition that could affect RPW development rates, and subsequently the size and fitness of adults.

Survey and Delimitation

- 1 Where is the optimal site/position for trap placement?
 - Bucket traps should be placed 1-2.5-m high on non-host trees, telephone poles or other structures/poles to avoid attracting weevils to healthy palm trees that they could then attack.

- If necessary, place traps on less preferred hosts, such as *Washingtonia* spp. Monitor for symptoms and apply prophylactic insecticide treatments. Host resistance has been noted for some *Washingtonia* species. However, there are many hybrids and distinguishing species is very difficult. Over 1000 individual larvae have been recovered from some species of *Washingtonia* palm trees. Also, native American palm trees like those growing in natural areas of California have not been studied in this respect.
- Traps can draw weevils to uninfested areas. Therefore, special care should be taken to monitor the traps and surrounding palm trees regularly. Traps should remain in the core area as they will provide critical information on the level of infestation. Additionally, trap density may be increased following detection to reduce weevil populations. Traps should also be placed in ports and warehouses and other locations where palm trees are manipulated (e.g., green yard waste and refuse disposal sites) provided that they are located far away from palm tree growing areas.
- Baited traps are usually placed 15-20 m away from Canary Island date palm trees or other preferred host plants. Where adults actually land when responding to the pheromone is not known. They do not necessarily fly right into a trap, but may settle on suitable host or substrate nearby and walk around. It is therefore recommended that traps be placed as far away from preferred hosts as reasonably possible while maintaining necessary trap density.
- Food baits: The program in California is currently using apples as the food bait in traps; however, other food baits have been found to be more effective. The TWG recommends using 'date scent originating' material such as dates, date paste from processing, pieces of canary palm trees, etc. chopped and placed in coolant/water mixture. For example, the date season in the Imperial and Coachella Valleys has just ended. Also, pieces of the frond petiole would be acceptable. They should have plenty of refuse, such as the shapeless sticky stuff that they sell to confectioners who use it for baking. In Jordan, "date honey" that comes in jars or cans is used and this has been found to be easier and less messy to use when baiting RPW traps.

Additional survey/trap sites:

- Areas/developments with recently transplanted trees, such as the recent development north of the original site, should also be targeted since stressed plants tend to attract adult weevils. In addition, it seems evident that the palm trees located in the original site were attacked one to two years ago and there is a great risk of other mature established trees in the area of being infested.
- Nurseries. At least one or two traps should be placed in large nurseries throughout State that deal with palm trees.
- Along trade routes/roads. New weevil infestations in Spain corresponded closely to roads along which palm trees were transported.
- Monitor further south (e.g., San Diego) for possible presence of weevils.

2 How far out should the survey be conducted?

- A 10-km (ca. 6.2 miles) radius (total diameter of 20-km) is set by the European Union around a red palm weevil detection. The TWG recommends adopting a similar sized buffer zone around new detections for survey and treatment activities.

- Surveys in home-garden areas are very difficult as there are no regular palm tree plantings and there is insufficient knowledge about spread under such conditions. It appears that placement of a higher density of traps will be beneficial. One way this can be done in a residential area would be to have each household maintain its own "personal trap" and report if it catches anything.
 - Traps in the core and buffer zone (see above) should be monitored through the spring and fall peaks of adult population (1 year) before reducing the number of traps in the grid. Movement away from the central core is obviously possible. In Israel, trees many miles away from known infestations were suddenly found to be infested with no palm trees between the areas to bridge the gap. As such, very close vigilance should be maintained on Canary Island date palm trees everywhere in the State.
 - Adults can find host plants in widely separated areas and can detect breeding sites >10-miles from the nearest host plant.
 - Adults aggregate and infestations occur in clusters; weevils prefer areas under heavy irrigation.
 - Adults prefer stressed or damaged trees and therefore trimming fronds will attract weevils.
 - Adults tend to attack the same tree resulting in multiple generations in a single tree.
3. Is the current trap density being used in CA appropriate? Should there be more (fewer?) traps? If so, where should they be located?
- The current trapping density is appropriate. However, the TWG recommends setting one trap per nursery. Traps should be inspected daily by owners as they may detect additional foci. Green yard waste and refuse areas should be monitored as well as infested palm trees removed by professionals or homeowners may end up in these areas.

Other dispersal mechanisms:

- Hitchhikes on trucks. In Aruba, adult weevils were found in the trucks that were used to transport lures, possibly leaking lures attracted the weevils that could be carried to new locations. New weevil infestations in Europe corresponded closely to roads where palm trees were transported. The TWG felt that it is very important to try and find the source of imported palm trees into the area and the US that are likely to be responsible for the RPW introduction. As the infested Phoenix palm tree in Laguna is evidently unlikely to be the source, all the nurseries around the current find must be checked very quickly and all owners of newly established palm trees (within the last two to three years) close to the infested core area should be contacted to try and identify the source of their palm trees. The implication is that there is likely to be another source of RPW outside the current infestation site that has not been identified yet.
- 3 How far should visual survey for larvae and pupae occur from each detection property? How effective is visual survey relative to traps?
- *P. canariensis* weevils are found more predominantly in the crown.

- In Israel, visual surveys were carried out up to a 1000-m radius. If no weevils were found, the inspections were stopped. If weevils were found, the radius of the inspection area was increased by another 1000-m until no new infestations are detected. Spain follows a similar protocol.
- It is difficult to identify palm trees with low infestation levels or early signs of symptoms. Visual symptoms appear four to six months after infestation.
- RPW attacks Canary Island date palm trees in the area of the terminal bud. Symptoms of attack are much more difficult to detect than with date palm trees where attacks are usually found in the offshoots and not in the crown.
- The TWG recommends that experts familiar with RPW infestation symptoms be identified that can be brought to CA in the very near future to help with visual survey efforts and train local inspectors on what to look for when surveying. However, it is important to recognize that even experts have difficulty identifying early infestations and that palm trees with very low or recent infestations go undetected.

Proposed Candidates:

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Dr. Robin Giblin-Davis-USA

Mr. Ami Haberman – in charge of RPW monitoring and control in Israel

Dr. Stefano Colazza - Italy

- The TWG recommends that in the future, local inspectors should be sent to areas with active infestations (Israel, Spain, and Sicily) so that they have a chance to see and learn the symptoms for all stages of infestation first hand.
- 4 How long after the last weevil detection should delimitation continue?
- Based on a 2010 study, the lifecycle model predicts less than two generations per year where the mean annual temperature is between 15° C (59° F) and 19° C (66.2° F). The lifecycle dependent on the climate can last from two to four months. In Spain, the generation developing from the end of the summer to spring the following year can last more than four months.
 - In Spain, if no new infested palm trees are detected and no weevils are trapped for three consecutive years since last detection, the focus is declared pest-free and the program shifts to monitoring. This is a EU requirement.

Treatment

1. What treatment options are available for infested trees? What are their efficacies? What concentrations of products are required to kill small, medium and large RPW larvae?
 - Drenches (on trees that are still able to translocate nutrients) with neonicotinoids and foliar sprays. This is especially important for nurseries. In Spain, foliar sprays of organophosphates (e.g., chlorpyrifos, phosmet) are recommended for application as

frequently as is necessary. In CA, the frequency will depend on how fast the insecticides degrade under local environmental conditions. The sprays are combined with drench applications of neonicotinoids (which could be also applied as a spray). In Spain, only two drench applications per year were enough to achieve good efficacies.

- Entomopathogenic nematodes (*Steinernema carpocapsae*/chitosan) could also be used as they have been shown to be compatible with imidacloprid applications. The nematodes need to be applied more frequently (1x month), which may increase costs. Treated palm trees should be regularly inspected.
- Injections are not preferred as wounds do not heal and may allow infection by pathogens. If injection is used, gear should be carefully disinfected after every single use. This technique should not be used if pathogens such as *Fusarium* are prevalent in the area.
- Generally in countries with weevil infestations, it is recommended that infested palm trees are removed unless of high economic value. Palm trees are difficult to burn and if incomplete the larvae and pupae may not be killed. Deep burial is discouraged. The method of disposal is critical since usual burial or burning + burial and insecticides do not kill pupae and adults.
- Sanitation (based on the traditional technique used for collecting ‘palm honey’, mainly in La Gomera island in the Canary Islands) should be used for ‘priceless’ monumental specimens. Once cured, these palm trees should be regularly treated to prevent new infestations.

Critical Outreach

- Homeowners and landscapers need to be provided appropriate treatment options
 - If homeowners are provided or use traps they need to be trained on how to service them properly and monitor/apply prophylactic treatments to their palm trees.
 - To avoid misuse of pesticides.
 - Provide control of all stages.
 - Proper disposal options.

Mass Trapping

The Middle East has employed mass trapping as part of an integrated pest management program in date production areas. It should be noted that traps could attract adult weevils to the area that will not necessarily enter the traps.

Quarantine

1. What are hosts?

- Canary Island Date Palms (*Phoenix canariensis*) appear to be preferred hosts well above other *Phoenix* spp. In Spain, the problem originated with the import of date palm tree, *Phoenix dactylifera*; Canary Islands date palm trees became infested afterwards.
- *Saccharum officinarum* (sugar cane) reported as hosts. However, forced infestation studies conducted in Egypt (in a cooperative project with Israel) have

shown that sugar cane is not attacked by the weevils. RPW larvae only develop on this plant when used as a diet medium. Sugarcane was never found to harbor RPW so, as of today, it is not a host, but can be used as rearing material.

- It is unknown if American species of Agave are field host.
2. Are there any treatments that would allow nursery stock to be moved out of a regulated area and if so, what are they?
- The most effective control is to stop movement of nursery stock from the area.
 - Eradication was effective in the Canary Islands because all movement of palm trees was prohibited.
 - In Israel, no nursery stock can move from an infested area, only movement within the area is allowed.
 - In the EU, movement from infested areas is possible only after a 1-yr period of physical confinement, with plants chemically treated and subjected to regular inspection (every 3 months). If the pest is detected in the meantime, depending on the importance of the outbreak, the whole lot can be destroyed. If the material comes from an infested third country, an extra year of confinement under the same conditions in the country of origin is compulsory (that means that these plants should have been subjected to a 2-yr period of quarantine)
 - Prophylactic pesticide treatments needed
 - Delay between infestation and detection. As plants should be inspected every 3 months for a 1-yr period, symptoms should appear if plants are indeed infested.
 - A mature infested palm tree can survive 3 summers, but symptoms should be evident much earlier. What is needed is a trained eye to see the damage on the new fronds. Also opening an 'inspection window' by cutting away a section of fronds would aid in early detection.
 - Foliar spraying will not kill larvae inside the trunk. Systemic products can reach the core of the palm tree and protect it against the weevil provided that damage is not so conspicuous that sap circulation is no longer "normal." Entomopathogenic nematodes (*Steinernema carpocapsae*/chitosan) can reach even these seriously damaged palm trees
 - Currently no detection method (visual, sound, odor) can guarantee that a palm tree is free of the weevil.
 - Insecticide treatments (imidacloprid and *Steinernema carpocapsae*/chitosan) were 83-99% effective in killing larvae in field treated trees in Spain.
 - 100% mortality of all life stages occurred when palm trees were fumigated with aluminum phosphide (2.0 g m⁻³). Small plants do not die at the effective rate, but their foliage is spoiled by the treatment, therefore they are not acceptable for commercial purposes. However, adult palm trees can survive the treatment and as these plants have to be kept under physical confinement and subjected to regular inspections for a 1-yr period after their introduction into EU, this treatment could be very useful.
 - In the EU, an area is considered free of the pest if an infestation has not been detected for 3 consecutive years.

Non-hosts

- The weevil may move as a hitchhiker particularly along transportation (trucking) routes.
3. Does Israel or Europe use a systems approach/certification program to allow movement of nursery material?
 - So far, not in Israel. Israel has a quarantine zone out of which no stock may be moved without exceptions. This precaution is also relevant since the date fruit growing region is less than an hour drive from the area of canary palm tree infestations. For home/backyard palm trees, quarantine is very complex and has no set rules. Traps and infested trees serve as guides and any suspect tree is removed.
 - In EU, movement from infested areas is possible only after a 1-yr period of physical confinement, with plants chemically treated and subjected to regular inspection (every 3 months). If the pest is detected in the meantime, depending on the importance of the outbreak, the whole lot can be destroyed. If the material comes from an infested third country, an extra year of confinement under the same conditions in the country of origin is compulsory (that means that these plants should have been subjected to a 2-yr period of quarantine).
 4. Are host plants (coconut, *Phoenix* spp.) not listed in the January 2010 Federal Order prohibited?
 - All reported RPW hosts are prohibited through the January 2010 and other prior regulations.
 5. How large an area should be put under quarantine regulation?
 - The TWG recommends following the EPPO model of a 3 zone quarantine (see excerpt from the Official Journal of the French Republic).

Chapter II

Definition of the Control Perimeter

Article 4- Upon official confirmation of infestation by the Plant Protection Agency through discovery of a plant infested by *Rhynchophorus ferrugineus* or a trap that captured the insect, 3 zones shall be demarcated from the point of discovery:

- An area contaminated by a minimum distance of 100 meters around the initial infestation point;
- A safety zone of a minimum distance of 100 meters around the contamination area;

- A buffer zone of a minimum distance of 10 Kilometers around the safety zone

The ensemble of these zones constitutes the control perimeter and shall be mapped by the Plant Protection Agency.

Article 5- Upon discovery of this insect outside the contamination area, the boundaries of the contaminated area and buffer zone shall be reviewed accordingly.

Article 6- When multiple buffer zones overlap or are geographically close to each other, the buffer zone is expanded to include the delineated areas and the zones that separate them.

6 What is the quarantine trigger?

- Given the economic importance of RPW and its cryptic life cycle, one live specimen (no matter sex or stage) or an infested host should be used as a trigger.

Disposal of Infested Trees

1. Can infested trees be treated or do they need to be cut down and destroyed?
 - Severely damaged trees (those no longer capable of translocation of systemic pesticides) should be removed and destroyed.
 - All palm material should be shredded (saw dust or $< 5 \text{ cm}^2$)
 - Pupae may escape if chipping fragments are too large.
 - Monitor areas where trees and other palm material are disposed.
 - Systemic (neonicotinoids) pesticides can be used for feeding larvae and contact pesticides can be used for emerging and flying adults.
 - In Spain, 10 ml 20% a.i. imidacloprid is applied per adult palm tree. Currently, new studies using other neonicotinoids are being conducted and preliminary results point at similar doses. Interestingly, these pesticides worked very similarly when applied either as a drench or as a foliar spray.
 - In Israel, Dinotefuran 20% and Acetamprid are presently used. The former is poured on the top of the canopy since it is relatively harmless to natural enemies and the environment and the latter is given as a drench.
2. How should a positive (infested) tree be safely removed?
 - Treat the crown to kill adults that may be present in the crown. Agitation of the palm from cutting it with a chainsaw may cause adults to fly.

- Wrap the crown to prevent adults from escaping during transportation to the disposal site.
 - Remove entire palm tree including trunk and fronds.
 - Prophylactic pesticide treatment (drench) of neighboring palm trees will be beneficial.
 - Make sure to clean the area, removing all pupae that may have dislodged from the crown/fronds.
 - Grind out the stump or paint it so it does not attract RPW.
 - Place a trap at the detection site.
3. How far below the soil line should a trunk of an infested tree be removed? What alternatives (e.g. pesticides treatments, etc.) are effective?
- Canary palm trees are attacked near the canopy so it is unlikely the trunk is infested. When possible the whole plant should be removed. If this is not possible, then at least the palm tree should be cut to ground level. Any remaining stump should be sealed with mastic and treated with a pesticide. In Israel the stump is sealed with tar. The remaining stump should be monitored for several months to verify that all stages have been destroyed. In Israel when other species of palm trees are cut, they coat the remaining stump with tar and monitor it for some months. The method of making cuts into the stump and using a mixture of kerosene and insecticides is mainly useful when isolated stumps in the desert areas are to be left alone after cutting.

Potential Pathways for Spread

1. Can fronds alone support weevil development and be a pathway for spread?
- Fronds could contain pupae and late instar larvae (that could pupate). Due to the large size they or their damage should be seen at the base of the frond where it attaches to the tree. Any suspect tunneling or darkened areas should be carefully inspected.